

February 1996

Preliminary Data Summary

by Field Research Facility

U.S. Army Corps of Engineers
Waterways Experiment Station
Coastal Engineering Research Center
1261 Duck Road
Duck, NC 27949-4472

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Preface

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

These reports are now available via the World Wide Web at
<http://frf.wes.army.mil/frf.html>

These web pages contain general information about the Field Research Facility and data from 1980 to the present.

Your comments and criticisms are welcome.

Introduction

1

The U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's (CERC) Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.75 m above the National Geodetic Vertical Datum (NGVD) of the year 1929.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local bathymetric, oceanographic, and meteorological conditions. This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Clifford F. Baron at (919) 261-3511 (baron@duck.wes.army.mil).

Chapter 2 presents the meteorological data; Chapters 3 through 6 present oceanographic data; Chapter 7 presents nearshore profiles and bathymetry; and Chapter 8, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used and their operational status during the month. Figure 2 shows weather and ocean conditions for the month. Table 2 and Figure 3 identifies the location of the instruments. The water depths at the wave gauges and current meters vary and may be determined from information contained in Figure 9. Other installation information is contained in Table 1.

Times given in the report are referenced to eastern standard time (EST).

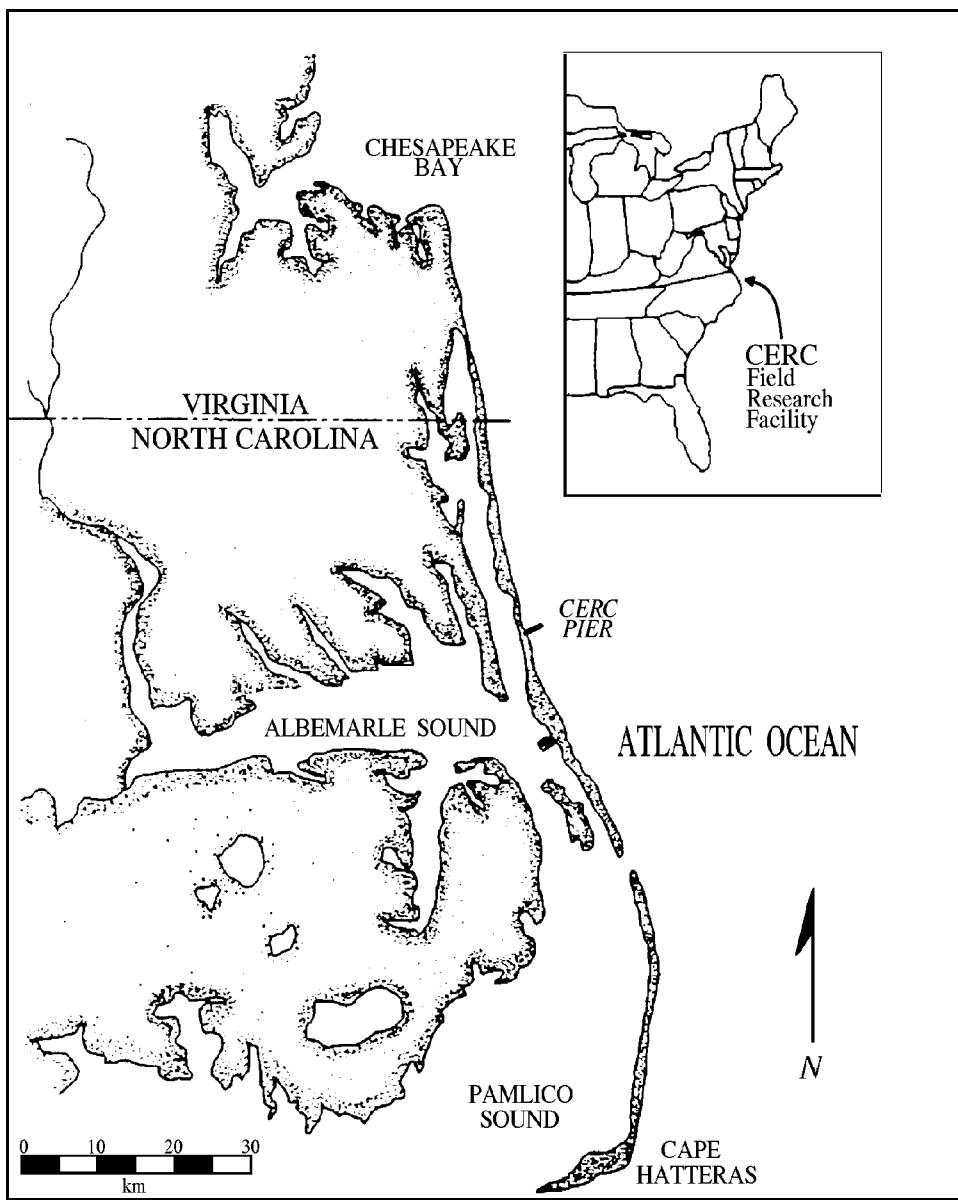


Figure 1. FRF Location Map

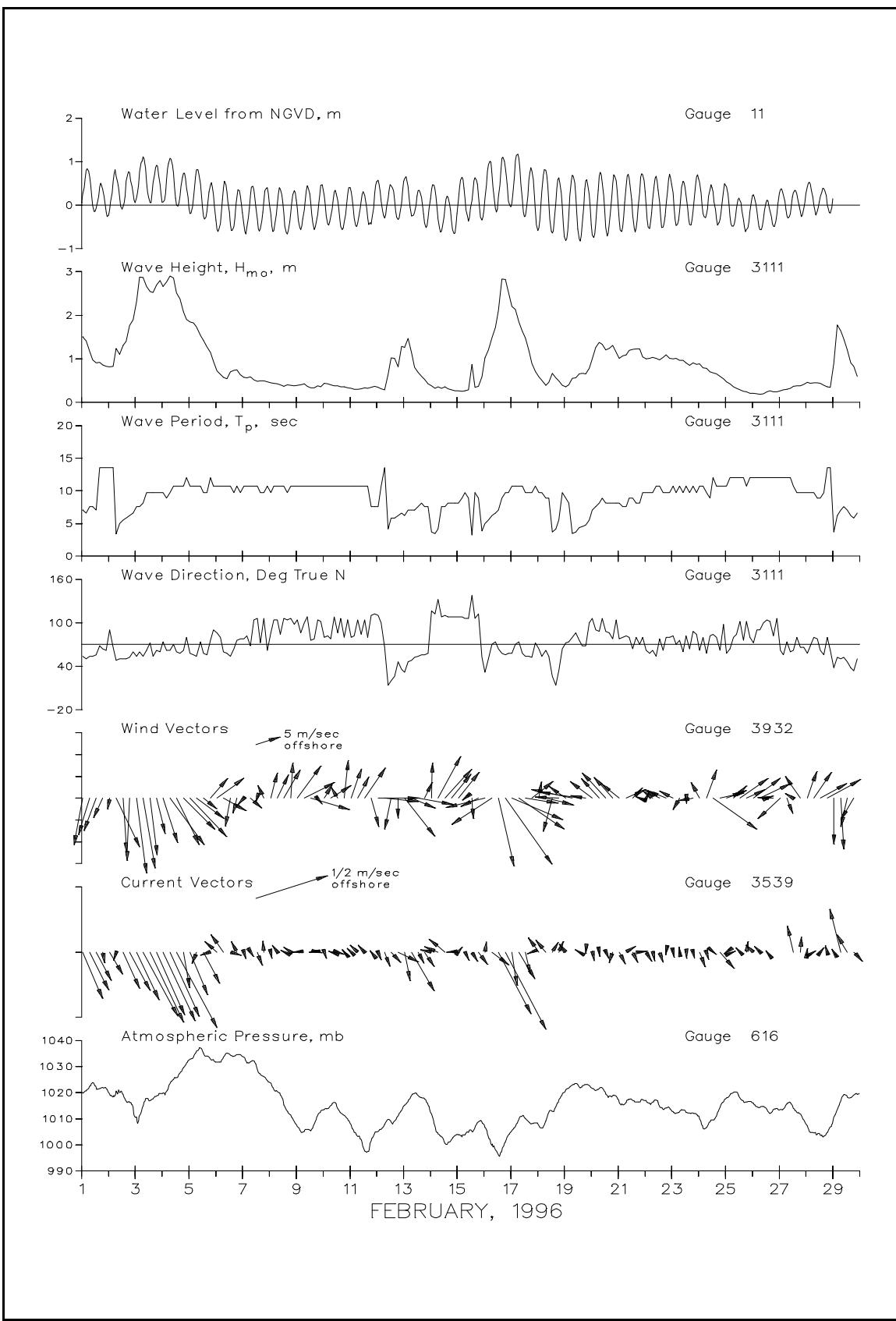


Figure 2. Month at a Glance

Table 1
Instrument Status/Data Availability

		February 1996																												
		Day of the month																												
Gauge ID	Description/Remarks	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9
616	Atmospheric Pressure	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
604	Precipitation	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
624	Air Temperature	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
3932	Anemometer	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
641	Pressure Gauge on FRF pier	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
625	Baylor staff on FRF pier	*	*	/	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
		Data Collected	*	*	/	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
3111	8 Meter Array 309 m north of FRF	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
111	Pressure Gauge center of 8 Meter Array	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
630	Waverider buoy 4.0 km offshore	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
3539	Current meter 343 m north of FRF pier (1.6 km offshore)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
11	NOAA tide gauge at end of pier	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
Visual Observations (daily oceanographic and meteorological observations)		Daily observation	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
Gauge Status		*	= Operational	/	= Partial	-	= Non-Operational																							
Data Collected		*	= All	/	= Partial	-	= None																							
Visual Observations		*	= Complete	/	= Partial	-	= None																							

Table 2
Gauge Locations

Gauge*	Description	* Latitude	* Longitude	* FRF Coordinates	* Gauge Depth	* Water Depth
ID *		Degrees N	Degrees W	CrossshoreT Longshore*	NGVD, m	NGVD, m
S))))))0)))))))))))))))))))0)))))))))))))))0)))))))))))))))0)))))))))))0)))))))))))0)))))))))))0)))))))))))Q						
616 * Atmospheric Pressure*	36 10' 57.03"	*	75 45' 5.50"	*	11.60 *	569.00 *
	*	*	*	*	*	*
3932 * Anemometer	36 11' 1.23"	*	75 44' 43.07"	*	585.20 *	517.30 *
	*	*	*	*	*	*
641 * Pressure Gauge	36 10' 57.71"	*	75 44' 56.23"	*	239.11 *	516.64 *
	*	*	*	*	*	*
625 * Baylor Staff	36 11' 1.04"	*	75 44' 43.72"	*	568.00 *	516.64 *
	*	*	*	*	*	*
3111 * 8 Meter Array North	36 11' 19.14"	*	75 44' 36.41"	*	915.23 *	990.16 *
	*	*	*	*	*	*
	* 8 Meter Array South	36 11' 11.28"	*	75 44' 33.28"	*	914.20 *
	*	*	*	*	*	*
	* 8 Meter Array East	36 11' 13.70"	*	75 44' 32.56"	*	954.51 *
	*	*	*	*	*	*
	* 8 Meter Array West	36 11' 12.48"	*	75 44' 37.11"	*	834.66 *
	*	*	*	*	*	*
111 * Pressure Gauge in	36 11' 14.06"	*	75 44' 34.39"	*	914.43 *	825.52 *
	* center of 8 M Array	*	*	*	*	*
	*	*	*	*	*	*
630 * Waverider Buoy	36 10' 5.10"	*	75 41' 59.30"	*	3934.96 * -2400.81	Surface *
	*	*	*	*	*	*
3539 * Current Meter	36 11' 23.57"	*	75 44' 9.12"	*	1605.80 *	907.60 *
	*	*	*	*	*	*
11 * NOAA Tide Gauge	36 11' 1.25"	*	75 44' 42.60"	*	596.49 *	514.20 *
	*	*	*	*	*	*
R	R	R	R	R	R	R

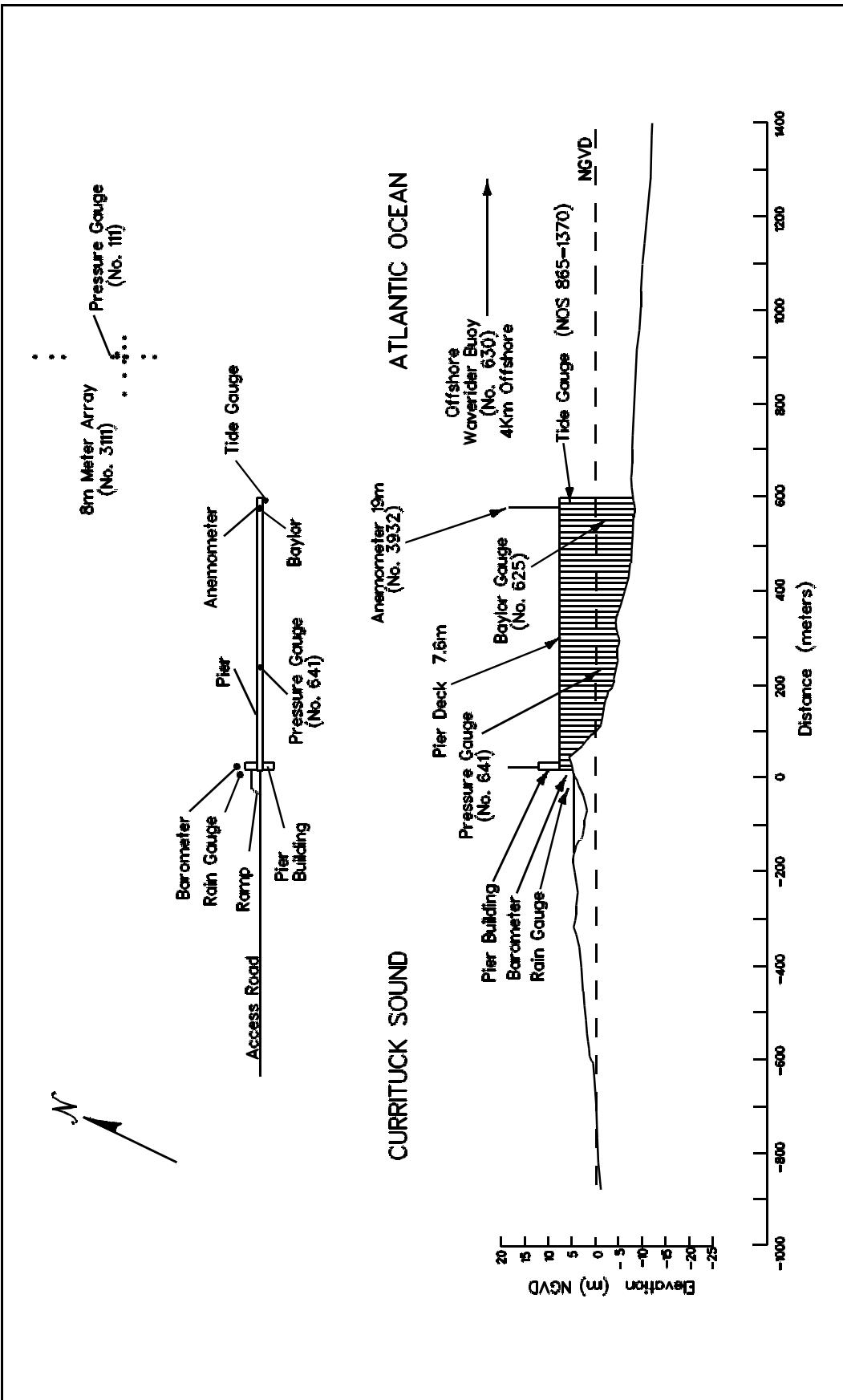


Figure 3. Instrument Locations, Elevations From NGVD

Meteorological Data

2

A variety of instruments have been installed at the FRF (Figure 3) to monitor the meteorological conditions. The data presented in Table 3 are collected and stored using a Digital Equipment Corporation VAXstation 4000. For each instrument identified in Table 1, a log is maintained and the records are stored for future reference.

Winds were measured at the end of the pier at an elevation of 19 m using a WeatherMeasure Skyvane anemometer. Monthly resultant wind speeds and directions (Figure 4) are determined by vector averaging the data. Wind directions (Table 3) indicate where the wind is coming from. Temperature and atmospheric pressure means (Table 3) are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 3 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -
 $mm \times .03937 = in.$
2. Millibars (mb) to inches of mercury (in. Hg) -
 $mb \times 0.02953 = in. Hg$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -
 $(C \times 9/5) + 32 = F$
4. Meters per second (m/s) to knots (kn) -
 $m/s \times 1.943 = kn$

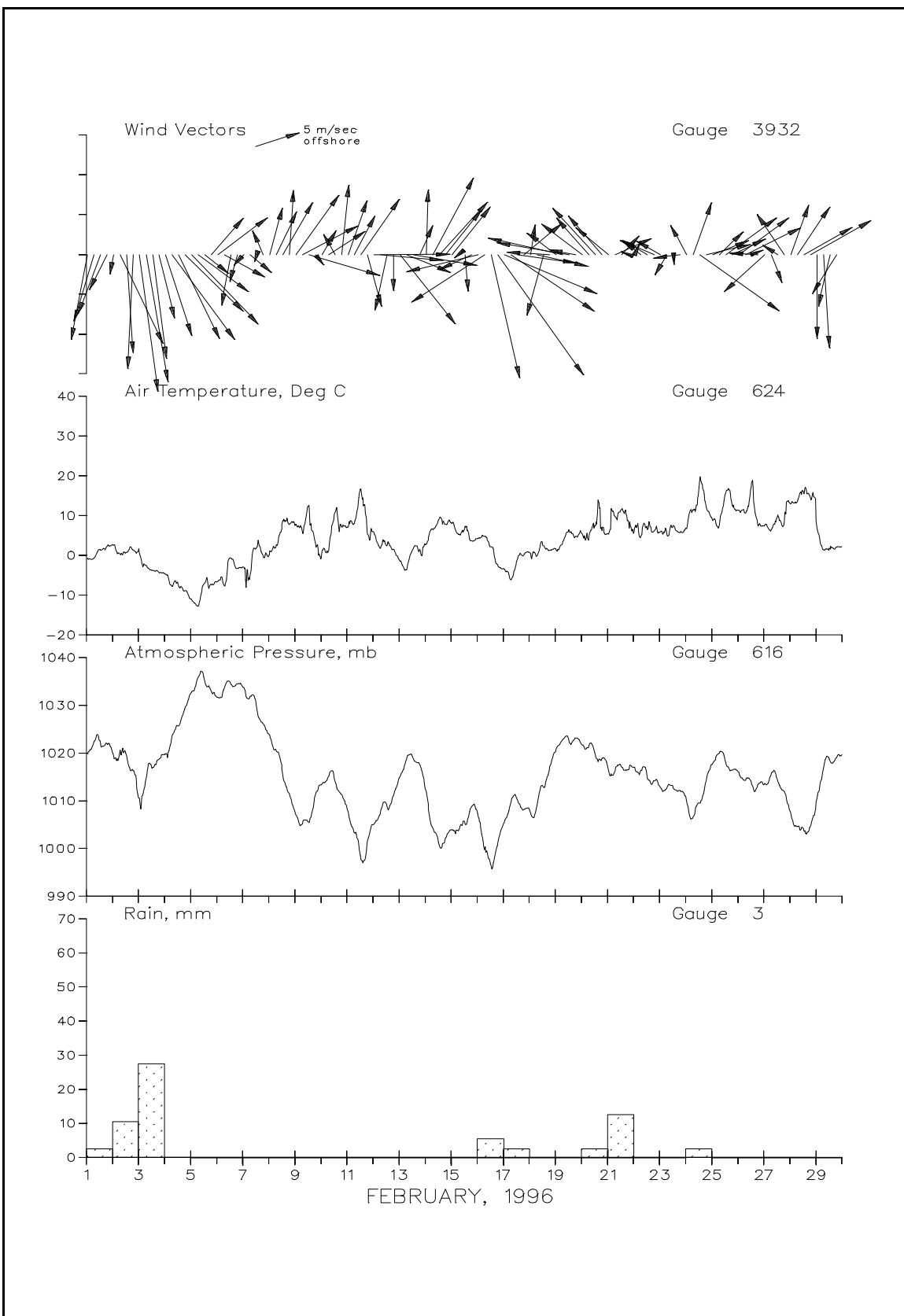


Figure 4. Meteorological Monthly Summary

Table 3
Meteorological Data

Feb 1996						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
1	100	11	9	-0.7	1019.9	0
	700	9	14	-0.7	1022.5	3
	1300	8	18	1.3	1022.0	0
	1900	5	23	2.2	1022.0	0
2	100	2	8	2.6	1019.4	0
	700	12	337	0.3	1020.6	10
	1300	12	356	0.8	1019.3	0
	1900	14	2	1.4	1016.3	0
3	100	17	353	0.7	1010.7	0
	700	16	351	-2.5	1015.0	28
	1300	13	353	-3.8	1017.0	0
	1900	8	348	-4.3	1018.7	0
4	100	11	344	-4.7	1019.9	0
	700	13	327	-7.8	1023.6	0
	1300	11	337	-7.7	1025.7	0
	1900	10	318	-8.8	1029.7	0
5	100	11	320	-11.3	1032.8	0
	700	7	310	-12.7	1036.0	0
	1300	3	312	-7.0	1035.2	0
	1900	6	217	-7.4	1032.9	0
6	100	7	229	-6.5	1031.7	0
	700	5	303	-7.7	1033.8	0
	1300	6	8	-0.7	1034.5	0
	1900	4	13	-3.2	1034.6	0
7	100	2	37	-3.0	1033.8	0
	700	3	315	-4.9	1031.9	0
	1300	1	16	2.0	1028.9	0
	1900	3	158	-0.1	1026.2	0
8	100	6	193	1.2	1023.8	0
	700	6	202	2.7	1020.4	0
	1300	7	206	8.7	1015.3	0
	1900	8	183	7.8	1011.5	0
9	100	9	212	7.9	1007.0	0
	700	7	239	5.8	1005.1	0
	1300	8	289	12.6	1005.5	0
	1900	2	325	3.0	1011.3	0
10	100	3	206	1.3	1013.6	0
	700	5	233	1.0	1015.1	0
	1300	3	154	10.9	1014.0	0
	1900	9	185	7.1	1011.4	0

Table 3
Meteorological Data (continued)

Feb 1996						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
11	100	7	196	7.1	1007.7	0
	700	5	204	8.0	1003.4	0
	1300	8	211	16.7	997.7	0
	1900	7	346	5.4	1001.7	0
12	100	8	269	5.7	1005.2	0
	700	7	276	1.8	1007.8	0
	1300	7	10	2.5	1008.8	0
	1900	5	1	1.6	1011.2	0
13	100	11	325	-1.5	1015.2	0
	700	5	295	-3.6	1018.8	0
	1300	7	281	1.7	1018.9	0
	1900	4	201	1.5	1017.6	0
14	100	8	181	2.8	1011.9	0
	700	11	204	6.5	1004.3	0
	1300	8	218	9.2	1000.6	0
	1900	7	214	7.9	1002.2	0
15	100	7	214	8.0	1003.9	0
	700	1	46	5.2	1003.8	0
	1300	5	356	7.3	1005.1	0
	1900	4	61	3.7	1008.8	0
16	100	8	74	4.3	1006.7	0
	700	10	52	4.8	999.8	5
	1300	16	348	2.1	996.3	0
	1900	18	328	-2.5	1001.2	0
17	100	11	296	-3.5	1005.5	0
	700	11	308	-6.2	1009.7	3
	1300	6	279	-1.0	1010.2	0
	1900	6	226	0.1	1008.2	0
18	100	4	187	0.6	1007.5	0
	700	6	285	-0.1	1009.1	0
	1300	8	13	2.4	1012.8	0
	1900	5	1	1.4	1017.2	0
19	100	4	130	1.3	1021.0	0
	700	8	104	3.4	1022.9	0
	1300	8	100	6.0	1022.2	0
	1900	3	1	4.9	1023.2	0
20	100	6	130	5.4	1021.7	0
	700	6	142	4.9	1021.6	3
	1300	7	141	7.4	1019.5	0
	1900	6	142	6.2	1018.9	0

Table 3
Meteorological Data (concluded)

Feb 1996						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
21	100	5	133	5.4	1016.3	0
	700	4	242	9.7	1016.4	13
	1300	3	219	11.6	1017.1	0
	1900	1	112	8.7	1016.5	0
22	100	1	201	7.1	1017.0	0
	700	3	129	4.9	1016.4	0
	1300	3	122	6.5	1014.7	0
	1900	4	1	6.3	1014.2	0
23	100	3	122	6.0	1012.8	0
	700	3	27	5.1	1012.9	0
	1300	1	358	7.5	1012.5	0
	1900	3	80	5.7	1012.2	0
24	100	4	154	6.7	1009.9	0
	700	7	197	11.5	1006.7	3
	1300	11	309	19.2	1009.6	0
	1900	5	255	12.1	1014.3	0
25	100	4	245	8.8	1017.9	0
	700	4	222	7.7	1020.0	0
	1300	7	230	15.9	1017.9	0
	1900	4	241	12.8	1016.5	0
26	100	7	229	11.3	1016.1	0
	700	7	240	10.6	1014.4	0
	1300	1	246	18.3	1013.5	0
	1900	3	1	7.3	1013.5	0
27	100	6	43	7.6	1013.6	0
	700	4	341	6.6	1015.7	0
	1300	2	1	10.2	1014.1	0
	1900	6	149	8.5	1012.0	0
28	100	6	197	13.1	1007.2	0
	700	7	210	13.6	1004.6	0
	1300	6	236	15.5	1003.6	0
	1900	8	237	14.4	1004.7	0
29	100	11	359	6.7	1010.6	0
	700	12	356	1.4	1017.0	0
	1300	7	11	1.6	1018.3	0
	1900	6	1	2.1	1019.1	0
Resultant				Mean	Mean	Total
	2	304	3.8	1015.2	68	

Wave Data

3

Wave data are collected from three different sets of instruments, as shown in Table 1 and Figure 3. The first is an array of fifteen pressure gauges, collectively referred to as gauge 3111 (gauge 111 being one of them). Directional information is computed from these gauges using a iterative maximum likelihood estimator. The second is a Baylor staff gauge (625) and a pressure gauge (641), both attached to the pier. The third is a Waverider buoy (630). The data are collected, analyzed, and stored on optical disc using a Digital Equipment Corporation VAXstation 4000. Data is sampled at 2 hertz, with five contiguous 34 minute records, for a total collection period of nearly 2 hours and 51 minutes. This report reflects the data collection periods of 0100, 0700, 1300, and 1900 EST. The results are based only on the first 34 minute record. The exception is the 8 Meter Array (3111) which condenses the first four records into one statistical value.

Wave height H_{mo} is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gauge has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 degrees of freedom calculated from a 34-min record. Peak wave period T_p is defined as the period associated with the maximum energy in the spectrum.

Table 4 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 4 are average values computed from this data. Figure 5 is a time history of all H_{mo} and T_p values obtained for all gauges.

Differences in wave periods between wave gauges (Table 4 and Figure 5) may be the result of wave breaking, wave reformation, the presence of multiple wave trains containing nearly equal energy, and statistical variations in spectral estimations.

Table 4
Wave Data

Feb 1996										
Day	Hour	641 Pressure Gauge		625 Baylor Gauge		3111 8 Meter Array			630 Waverider	
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec
1	0100	0.83	6.1	1.41	6.3	1.51	7.1	54	1.64	6.8
	0700	0.78	6.1	1.31	7.4	1.17	7.6	54	1.38	6.3
	1300	0.45	13.5	0.94	7.0	0.90	7.1	56	1.00	7.2
	1900	0.47	6.1	0.83	12.9	0.87	13.6	64	0.94	13.5
2	0100	0.36	12.2	0.77	13.5	0.82	13.6	90	0.88	12.9
	0700	0.54	4.8	1.10	12.9	1.24	3.4	48	1.08	4.5
	1300	0.73	5.2	1.18	5.1	1.31	5.6	50	1.44	5.0
	1900	1.06	6.5	1.76	6.3	1.77	6.2	52	1.73	6.5
3	0100	0.97	7.2	1.93	6.9	2.32	7.6	54	2.52	7.2
	0700	1.33	7.8			2.87	8.2	54	2.94	7.8
	1300	0.86	10.3			2.54	9.8	72	2.92	9.9
	1900	1.24	7.6			2.69	9.8	62	2.67	8.1
4	0100	0.98	9.9			2.66	9.8	74	2.72	9.2
	0700	1.35	9.5			2.90	9.8	62	2.78	8.6
	1300	0.92	11.2			2.51	10.8	60	2.77	11.2
	1900	1.22	11.2			2.07	10.8	62	2.42	11.2
5	0100	0.84	11.7			1.85	10.8	58	1.92	11.2
	0700	1.15	6.8			1.73	10.8	54	2.58	10.7
	1300	0.76	11.2			1.42	9.8	58	1.55	10.7
	1900	0.66	11.7			1.14	12.0	76	1.31	11.2
6	0100	0.28	12.2	Gauge		0.73	10.8	86	0.83	10.7
	0700	0.24	10.7			0.57	10.8	60	0.65	11.2
	1300	0.40	3.4			0.70	10.8	54	0.72	10.7
	1900	0.45	4.6			0.75	10.8	76	0.84	10.7
7	0100	0.30	4.5	Inoperative		0.58	10.8	78	0.63	11.7
	0700	0.31	10.7			0.58	10.8	68	0.60	10.7
	1300	0.23	10.7			0.49	10.8	106	0.54	10.7
	1900	0.22	9.9			0.50	9.8	106	0.51	9.9
8	0100	0.17	10.7			0.45	9.8	86	0.52	10.3
	0700	0.19	10.7			0.42	10.8	104	0.47	10.7
	1300	0.13	10.7			0.37	10.8	106	0.44	10.7
	1900	0.16	10.7			0.40	10.8	106	0.43	11.2
9	0100	0.16	11.7			0.40	10.8	104	0.47	9.9
	0700	0.19	11.2			0.42	10.8	100	0.46	10.7
	1300	0.17	11.7			0.33	10.8	76	0.49	10.3
	1900	0.22	11.2			0.38	10.8	104	0.50	10.7
10	0100	0.21	11.2			0.43	10.8	80	0.43	9.5
	0700	0.18	4.5			0.40	10.8	78	0.47	9.9
	1300	0.18	11.2			0.38	10.8	86	0.42	10.3
	1900	0.12	10.7			0.36	10.8	80	0.43	10.7

Table 4
Wave Data (continued)

Feb 1996										
Day	Hour	641 Pressure Gauge		625 Baylor Gauge		3111 8 Meter Array			630 Waverider	
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec
11	0100	0.17	10.7			0.32	10.8	80	0.41	9.9
	0700	0.12	10.7			0.30	10.8	104	0.44	10.7
	1300	0.18	10.3			0.34	10.8	104	0.42	7.2
	1900	0.16	4.5			0.35	7.6	110	0.43	7.2
12	0100	0.22	7.8			0.34	7.6	110	0.56	7.6
	0700	0.17	3.6			0.29	13.6	66	0.45	11.2
	1300	0.85	6.0			1.03	5.9	20	1.17	6.3
	1900	0.67	5.9			0.82	6.2	46	1.19	6.1
13	0100	1.11	6.3	Gauge		1.26	6.2	32	1.73	6.1
	0700	0.93	6.8			1.13	7.1	48	1.72	7.0
	1300	0.57	6.0			0.69	7.6	54	0.81	7.2
	1900	0.30	5.4			0.53	7.6	56	0.64	8.1
14	0100	0.23	3.9	Inoperative		0.38	3.8	116	0.65	3.6
	0700	0.19	4.3			0.35	4.2	132	0.58	4.2
	1300	0.17	7.4			0.35	7.6	110	0.47	7.4
	1900	0.14	4.3			0.29	8.2	108	0.41	7.6
15	0100	0.16	5.1			0.27	8.2	108	0.34	7.8
	0700	0.14	10.7			0.26	9.8	106	0.30	7.6
	1300	0.15	10.3			0.87	3.3	138	0.36	9.9
	1900	0.24	9.9			0.37	8.9	112	0.46	10.7
16	0100	0.65	4.9			1.02	5.0	32	1.20	4.7
	0700	0.90	5.7			1.48	6.2	70	1.65	6.0
	1300	1.04	6.6			2.11	7.1	64	2.25	6.8
	1900	1.27	9.5			2.82	9.8	56	3.14	8.6
17	0100	1.04	9.9			2.21	10.8	58	2.70	10.3
	0700	1.26	10.3			1.85	10.8	74	2.12	10.7
	1300	0.89	9.5			1.49	9.8	54	1.64	9.5
	1900	0.63	10.3			0.89	9.8	52	1.00	9.5
18	0100	0.21	10.3			0.59	9.8	64	0.67	9.9
	0700	0.22	9.2			0.40	8.9	62	0.51	9.2
	1300	0.38	3.7			0.67	3.8	26	0.68	3.9
	1900	0.39	5.0			0.50	5.6	34	0.66	5.2
19	0100	0.19	4.6			0.35	8.9	72	0.44	4.5
	0700	0.31	3.4			0.55	3.5	80	0.64	3.4
	1300	0.31	3.9			0.65	4.4	76	0.75	4.2
	1900	0.35	4.9			0.66	4.8	68	0.69	4.5
20	0100	0.42	6.5			1.00	7.1	106	1.14	6.5
	0700	0.87	8.1			1.38	8.2	88	1.57	8.3
	1300	0.54	8.9			1.21	8.2	88	1.35	8.3
	1900	0.79	7.8			1.31	8.2	78	1.46	8.3

Table 4
Wave Data (concluded)

Feb 1996												
Day	Hour	641 Pressure Gauge			625 Baylor Gauge			3111 8 Meter Array			630 Waverider	
		Hmo,m	Tp,sec		Hmo,m	Tp,sec		Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec
21	0100	0.49	7.6					1.01	8.2	78	1.13	8.6
	0700	0.60	6.5					1.09	7.6	82	1.08	8.1
	1300	0.61	7.4					1.21	8.9	64	1.32	8.6
	1900	0.65	8.6					1.23	8.2	70	1.30	8.3
22	0100	0.56	7.8					1.00	9.8	62	1.06	8.9
	0700	0.56	10.3					1.03	9.8	62	1.09	9.2
	1300	0.54	10.3					0.98	10.8	78	1.04	9.9
	1900	0.54	10.3					1.09	9.8	80	1.14	9.5
23	0100	0.52	9.9	Gauge				1.00	10.8	82	0.90	9.5
	0700	0.50	10.3					0.97	10.8	76	1.00	10.3
	1300	0.45	9.9					0.90	10.8	82	0.96	10.3
	1900	0.44	9.9	Inoperative				0.90	10.8	88	0.98	9.5
24	0100	0.44	10.3					0.89	10.8	62	0.83	9.5
	0700	0.32	10.3					0.78	9.8	58	0.86	10.7
	1300	0.36	9.5					0.68	12.0	84	0.79	9.5
	1900	0.27	11.2					0.60	10.8	62	0.66	10.7
25	0100	0.23	10.7					0.47	10.8	58	0.53	11.2
	0700	0.15	11.7					0.35	12.0	80	0.41	11.2
	1300	0.14	11.2					0.29	12.0	102	0.30	11.7
	1900	0.09	11.7					0.24	10.8	102	0.29	11.7
26	0100	0.12	11.2					0.21	12.0	72	0.24	11.7
	0700	0.07	11.7					0.19	12.0	90	0.24	11.7
	1300	0.17	6.0					0.25	12.0	104	0.32	5.7
	1900	0.13	11.7					0.24	12.0	82	0.32	11.7
27	0100	0.15	11.7					0.26	12.0	62	0.30	11.7
	0700	0.18	2.6					0.30	12.0	74	0.41	12.2
	1300	0.19	10.7					0.37	10.8	62	0.39	11.2
	1900	0.16	10.3					0.39	9.8	66	0.40	8.1
28	0100	0.20	9.5	Gauge				0.46	9.8	58	0.53	8.3
	0700	0.20	4.2					0.44	9.8	80	0.50	10.3
	1300	0.22	5.9					0.44	8.9	62	0.50	8.6
	1900	0.17	14.3					0.37	13.6	80	0.40	8.9
29	0100	0.34	3.3					0.89	3.8	38	0.72	3.4
	0700	1.15	6.1	Inoperative				1.65	7.1	50	1.85	7.0
	1300	0.89	7.0					1.20	7.1	46	1.45	7.6
	1900	0.63	5.6					0.82	5.9	34	0.99	6.1
Mean		0.47	8.4		1.25	8.7		0.90	9.2	74	1.01	8.9
Std dev		0.34	2.8		0.38	3.2		0.67	2.4	22	0.72	2.3

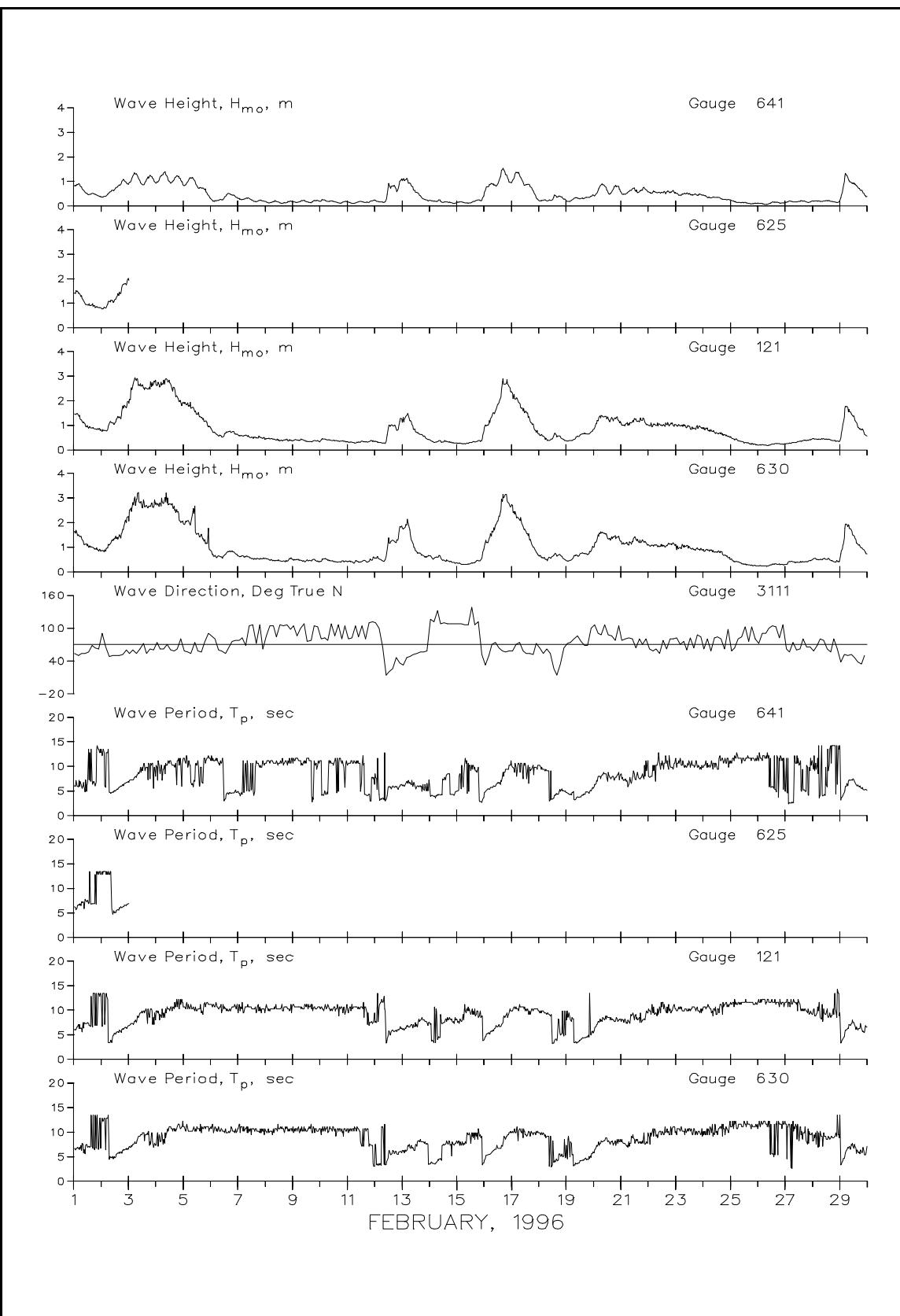


Figure 5. Wave Heights and Periods

Current Data

4

Current data (Table 5) are collected from a Marsh-McBirney electromagnetic biaxial current meter and by visually observing the movement of small drogues on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier, approximately 12 m offshore (Table 6).

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward). All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the cross-shore and longshore data. Current directions indicate the direction that the current is moving towards. Current data are plotted in Figure 2.

Table 5
Current Meter Data - Gauge 3539

FEBRUARY 1996																	
	Cross				Long					Cross				Long			
Day	Time	Shore	Shore	Speed	Dir	Day	Time	Shore	Shore	Speed	Dir	Day	Time	Shore	Shore	Speed	Dir
1	100	0	38	38	160	1900	1	-1	2	323		1300	0	5	5	158	
	700	-1	32	32	156	11	100	2	-3	4	317		1900	5	7	9	195
	1300	-1	24	24	155		700	3	-6	7	316	21	100	0	10	10	157
	1900	2	8	8	173		1300	2	-5	6	321		700	-6	-1	8	57
2	100	-1	19	19	153		1900	0	0	0			1300	0	8	8	158
	700	4	5	7	195	12	100	0	6	6	160		1900	-4	1	5	85
	1300	0	30	30	159		700	1	12	12	162	22	100	0	8	8	153
	1900	-2	32	32	155		1300	-2	10	10	142		700	1	7	7	171
3	100	-1	39	39	158		1900	-9	12	15	119		1300	0	8	8	163
	700	-4	54	54	155	13	100	4	22	22	170		1900	1	2	2	187
	1300	-2	58	58	157		700	-3	33	33	153	23	100	1	4	4	170
	1900	0	51	52	159		1300	0	9	9	156		700	0	-3	4	352
4	100	-1	56	56	158		1900	-1	12	13	152		1300	2	5	5	178
	700	0	53	53	159	14	100	6	-3	7	281		1900	1	5	5	168
	1300	-4	63	64	155		700	7	-6	10	294	24	100	1	12	12	162
	1900	5	27	28	171		1300	6	-12	14	314		700	1	6	6	167
5	100	0	35	35	161		1900	3	0	3	263		1300	0	2	3	134
	700	6	7	9	200	15	100	-3	-1	4	36		1900	-3	15	16	144
	1300	-1	26	26	156		700	0	7	7	157	25	100	2	1	2	229
	1900	7	0	7	248		1300	0	8	8	151		700	0	0	0	
6	100	5	-9	11	315		1900	-1	11	11	148		1300	2	-3	4	319
	700	3	-14	15	327	16	100	-2	-6	8	6		1900	-2	-6	8	6
	1300	-5	5	8	109		700	-6	13	15	131	26	100	3	-6	7	317
	1900	1	-8	9	334		1300	-3	52	52	156		700	2	-4	6	318
7	100	0	5	5	163		1900	-4	65	65	156		1300	0	0	0	
	700	0	4	4	151	17	100	6	25	26	173		1900				
	1300	0	11	11	161		700	-2	23	23	153	27	100	inoperative			
	1900	-1	-7	8	355		1300	3	17	17	169		700				
8	100	1	5	5	170		1900	4	0	4	246		1300	-2	-19	20	348
	700	1	-5	6	327	18	100	3	-11	13	327		1900	-4	-9	11	4
	1300	2	-1	2	299		700	3	-10	11	325	28	100	0	-1	2	6
	1900	3	-4	6	307		1300	-5	-5	9	28		700	-1	0	2	54
9	100	3	0	3	263		1900	-4	-6	8	19		1300	-2	-1	4	35
	700	inoperative				19	100	2	-6	7	326		1900	0	-4	5	345
	1300	1	0	1	263		700	inoperative				29	100	0	-2	3	332
	1900	-2	2	3	102		1300	2	-1	3	305		700	-4	-32	33	348
10	100	0	5	5	164		1900	0	1	1	184		1300	2	-14	15	333
	700	1	0	2	292	20	100	1	7	7	169		1900	-2	8	9	143
	1300	-2	3	4	112		700	1	3	3	172						

KEY:

- +cross-shore = offshore, cm/sec
- cross-shore = onshore, cm/sec
- +longshore = south, cm/sec
- longshore = north, cm/sec
- Speed = Resultant speed, cm/sec
- Dir = Resultant direction, degrees true north

Table 6
Visually Observed Current Data

Feb 1996												
Day	Pier End				Mid-Surf Zone				Beach			
	Cross Shore	Long Shore	Speed	Dir	Cross Shore	Long Shore	Speed	Dir	Location	Speed	Dir	
1	0	61	61	160	-22	87	90	174	South	27	N	
2	0	102	102	160	0	76	76	160	South	79		
3	0	152	152	160	0	102	102	160	no observation			
4	18	122	123	151	0	152	152	160	South	58		
5	13	44	45	143	884	-610	1074	35	South	5		
6	5	10	11	70	36	29	46	109	South	61		
7	0	0	0		-3	28	28	166	South	30		
8	-11	-30	32	321	-7	-15	17	316	North	64	S	
9	10	-14	17	17	0	0	0		North	14	S	
10	0	0	0		27	30	41	118	South	14	N	
11	3	-34	34	346	-9	-30	32	323	North	17	S	
12	10	32	33	143	7	27	27	146	South	38		
13	9	61	62	151	10	68	68	151	South	98	S	
14	27	-27	37	25	7	-29	30	354	North	32	S	
15	0	-14	14	340	0	0	0		North	3	N	
16	-8	55	56	169	0	41	41	160	South	40	N	
17	0	68	68	160	3	51	51	157	South	37	N	
18	0	16	16	160	3	61	61	157	South	24	N	
19	0	-55	55	340	0	-36	36	340	North	30	N	
20	0	-14	14	340	0	-122	122	340	North	55	N	
21	11	16	19	70	3	-34	34	346	North	35	N	
22	-1	8	9	169	39	-20	44	43	North	34	N	
23	-2	-12	12	331	4	-36	36	346	North	44	N	
24	9	12	16	123	38	-36	52	26	North	15	N	
25	5	20	21	70	6	-9	11	17	North	8	S	
26	23	-27	35	20	7	10	12	70	North	2	S	
27	0	8	8	160	12	7	14	70	North	18	N	
28	23	-13	27	40	25	-23	34	26	North	27	N	
29	0	61	61	160	0	61	61	160	South	30	N	

KEY:

- +cross-shore = offshore, cm/sec
- cross-shore = onshore, cm/sec
- +longshore = south, cm/sec
- longshore = north, cm/sec
- Speed = Resultant speed, cm/sec
- Dir = Resultant direction, degrees true north

Visual Observations

5

Visual wave direction measurements (Table 7) of both the primary wave train (i.e. that having the higher wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The direction of the primary wave train just north of the seaward end of the pier is also determined using a Raytheon Marine Pathfinder radar and measuring the alignment of the wave crests at approximately the same location as the visual measurements. The pier axis (considered perpendicular to the beach at the FRF) is oriented 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and depth of visibility are also taken daily at the seaward end of the pier. A Bucket Thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The temperature is then read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the depth of visibility.

Table 7
Visual Observations

Feb 1996							
Day	Time	Wave Approach Angle at Pier End deg from True N		Water Characteristics at Pier End			
		Primary	Secondary	Width of Surf Zone,m	Temp.,C	Density g/cc	Secchi Vis.,m
1	0730	40		180	3.1	1.0202	0.9
2	0736	20		171	3.3	1.0100	0.9
3	2020	50		437	2.5	1.0160	0.3
4	1120	40		360	2.5	1.0080	0.3
5	0815	45		195	1.7	1.0218	0.3
6	0810	10		34	2.5	1.0248	0.6
7	0755	5		26	1.9	1.0242	0.9
8	0630	95	130	20	2.2	1.0236	1.2
9	0740	110	150	29	3.9	1.0266	0.9
10	1006	15	50	18	4.7	1.0264	1.8
11	0750	125		9	4.2	1.0263	1.2
12	0740	5		11	4.2	1.0278	1.2
13	0730	25		186	2.8	1.0222	0.9
14	0730	125		17	3.6	1.0240	1.2
15	0730	135		12	4.4	1.0250	1.8
16	0730	70		183	3.6	1.0226	1.5
17	0820	20		229	2.5	1.0226	0.3
18	0920	350		35	3.6	1.0242	0.6
19	0730	85		32	3.3	1.0234	1.2
20	0730	95		191	3.9	1.0255	0.3
21	0734	90		47	4.4	1.0252	1.5
22	0710	120		181	3.9	1.0238	1.5
23	0710	90		187	4.4	1.0244	0.9
24	1045	65	145	35	5.8	1.0236	1.8
25	0800	110	355	15	5.8	1.0227	2.4
26	0720	100	70	11	6.1	1.0228	1.8
27	0710	45		14	7.2	1.0236	2.4
28	0720	140		21	6.9	1.0214	2.1
29	0735	20		203	5.8	1.0221	0.9

Water Levels

6

Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A NOS acoustic tide gauge (Next Generation Water Level Measurement System, NGWLMS) is used to collect water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 6 along with a list of means and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level. Table 8 contains the range, high, low, and mean water level for each 12.42-hr tidal cycle.

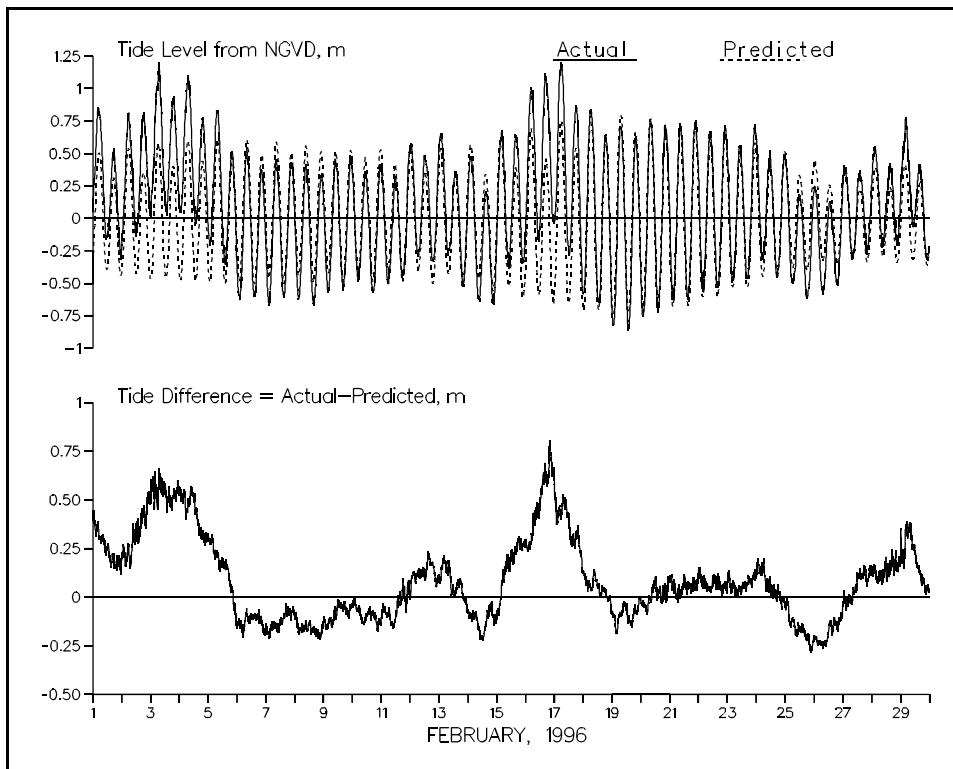


Figure 6. Water Level Variation

Table 8
Water Levels, m NGVD

FEB 1996 Tide Levels																
Day	High			Low			Mean	Range	High			Low			Mean	Range
	Time	m	Day	Time	m	Day			Time	m	Day	Time	m	Day		
1	0436	0.86	31	2354	0.00	0.55	0.86	15	1542	0.65	15	1012	-0.39	0.15	1.04	
1	1736	0.54	1	1124	-0.17	0.17	0.70	16	0500	1.01	15	2130	-0.35	0.33	1.36	
2	0600	0.81	1	2318	-0.32	0.25	1.13	16	1618	1.12	16	1118	-0.18	0.49	1.30	
2	1836	0.82	2	1206	-0.14	0.33	0.96	17	0536	1.20	16	2342	-0.04	0.56	1.25	
3	0718	1.21	3	0006	0.02	0.59	1.19	17	1806	0.87	17	1224	-0.28	0.29	1.15	
3	1918	0.94	3	1354	0.02	0.49	0.92	18	0618	0.84	18	0006	-0.58	0.14	1.42	
4	0724	1.10	4	0042	0.05	0.57	1.06	18	1836	0.65	18	1242	-0.65	-0.01	1.30	
4	1948	0.77	4	1324	-0.06	0.36	0.83	19	0712	0.71	19	0048	-0.83	-0.06	1.54	
5	0712	0.83	5	0142	-0.21	0.31	1.04	19	1924	0.62	19	1330	-0.87	-0.11	1.49	
5	1942	0.52	5	1412	-0.36	0.08	0.87	20	0748	0.76	20	0206	-0.76	0.01	1.52	
6	0800	0.55	6	0212	-0.63	-0.06	1.18	20	2006	0.72	20	1424	-0.73	0.02	1.45	
6	2006	0.38	6	1418	-0.61	-0.12	0.99	21	0830	0.73	21	0218	-0.63	0.06	1.36	
7	0854	0.45	7	0236	-0.68	-0.10	1.13	21	2136	0.75	21	1454	-0.63	0.07	1.38	
7	2048	0.43	7	1454	-0.61	-0.08	1.04	22	0930	0.67	22	0324	-0.56	0.07	1.24	
8	0906	0.42	8	0312	-0.63	-0.10	1.05	22	2200	0.72	22	1536	-0.54	0.09	1.25	
8	2212	0.34	8	1548	-0.67	-0.16	1.02	23	1036	0.56	23	0412	-0.50	0.04	1.06	
9	0942	0.46	9	0348	-0.57	-0.06	1.03	23	2242	0.73	23	1606	-0.47	0.12	1.19	
9	2224	0.48	9	1600	-0.56	-0.04	1.04	24	1112	0.53	24	0506	-0.32	0.07	0.85	
10	1030	0.36	10	0448	-0.49	-0.07	0.84	24	2306	0.50	24	1700	-0.46	0.02	0.95	
10	2312	0.42	10	1654	-0.57	-0.08	0.99	25	1142	0.18	25	0642	-0.50	-0.17	0.69	
11	1206	0.33	11	0548	-0.51	-0.10	0.83	26	0030	0.25	25	1754	-0.62	-0.19	0.87	
12	0054	0.58	11	1718	-0.46	-0.06	1.04	26	1306	0.13	26	0724	-0.59	-0.23	0.72	
12	1154	0.49	12	0654	-0.30	-0.11	0.78	27	0118	0.41	26	1948	-0.52	-0.05	0.92	
13	0200	0.66	12	1924	-0.33	-0.16	0.99	27	1424	0.37	27	0754	-0.32	0.03	0.69	
13	1330	0.37	13	0706	-0.28	-0.04	0.65	28	0254	0.55	27	2006	-0.27	0.15	0.83	
14	0236	0.48	13	2018	-0.53	-0.01	1.01	28	1512	0.43	28	0900	-0.22	0.11	0.65	
14	1500	0.21	14	0942	-0.64	-0.20	0.85	29	0430	0.78	28	2106	-0.21	0.27	0.98	
15	0418	0.68	14	2142	-0.66	0.00	1.35	29	1618	0.41	29	1042	-0.07	0.18	0.48	

Bathymetry

7

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using the CRAB-Geodimeter surveying system; a Geodimeter 140-T self-tracking, electronic theodolite, distance meter, in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 7 shows the last survey in January 1996 and the survey(s) in February 1996 on profile line 188, located 517 m south of the pier.

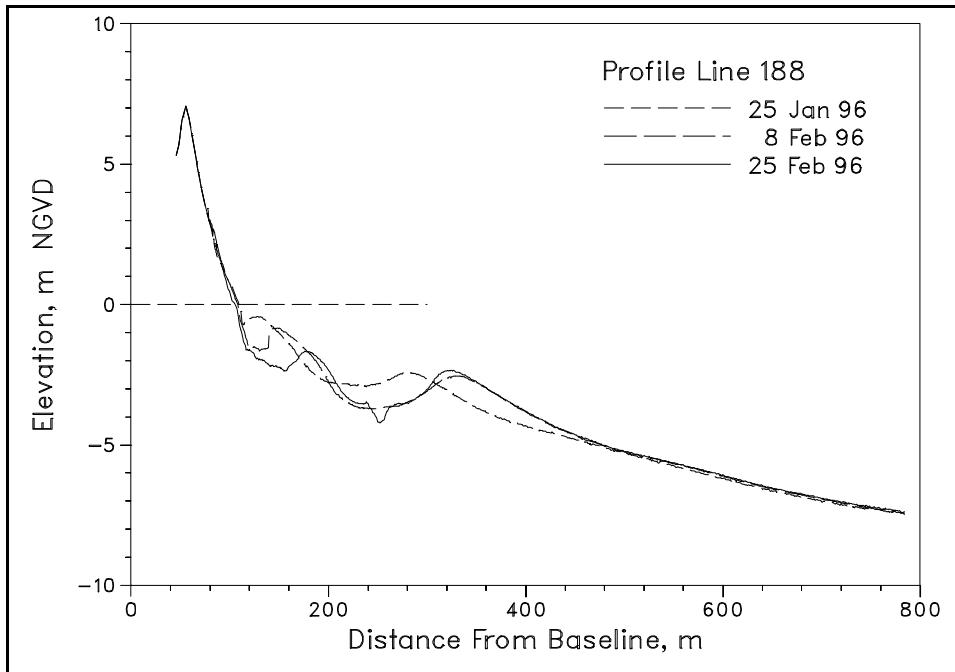


Figure 7. Monthly CRAB Profiles on Profile Line 188.

The profile envelope (Figure 8) reflects the maximum changes that occurred on the profile during 1996. Cross-hatched areas indicate changes to the annual envelope which occurred in February.

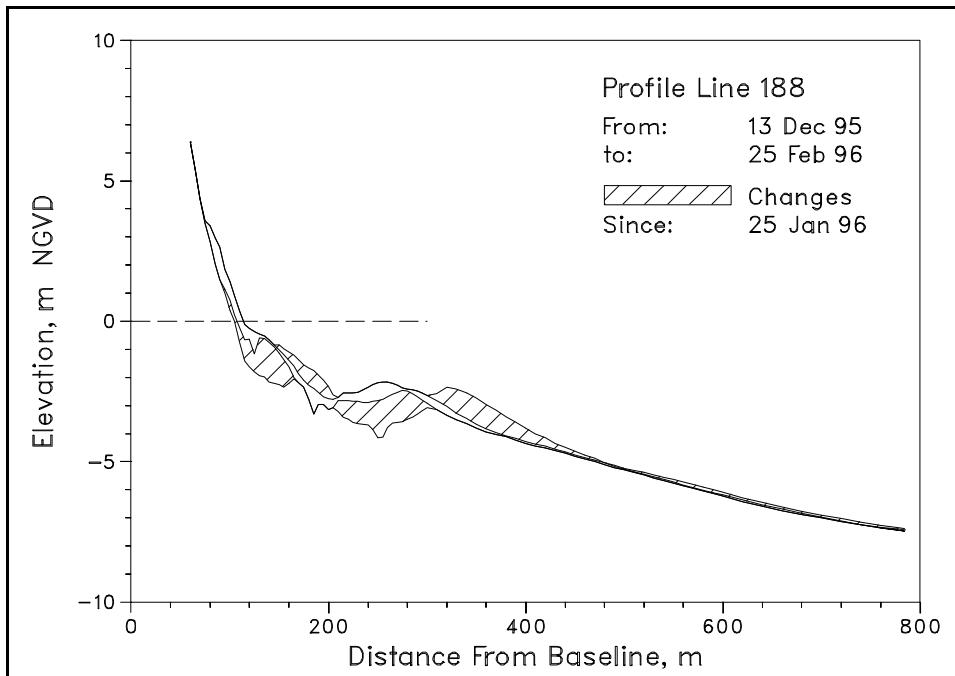
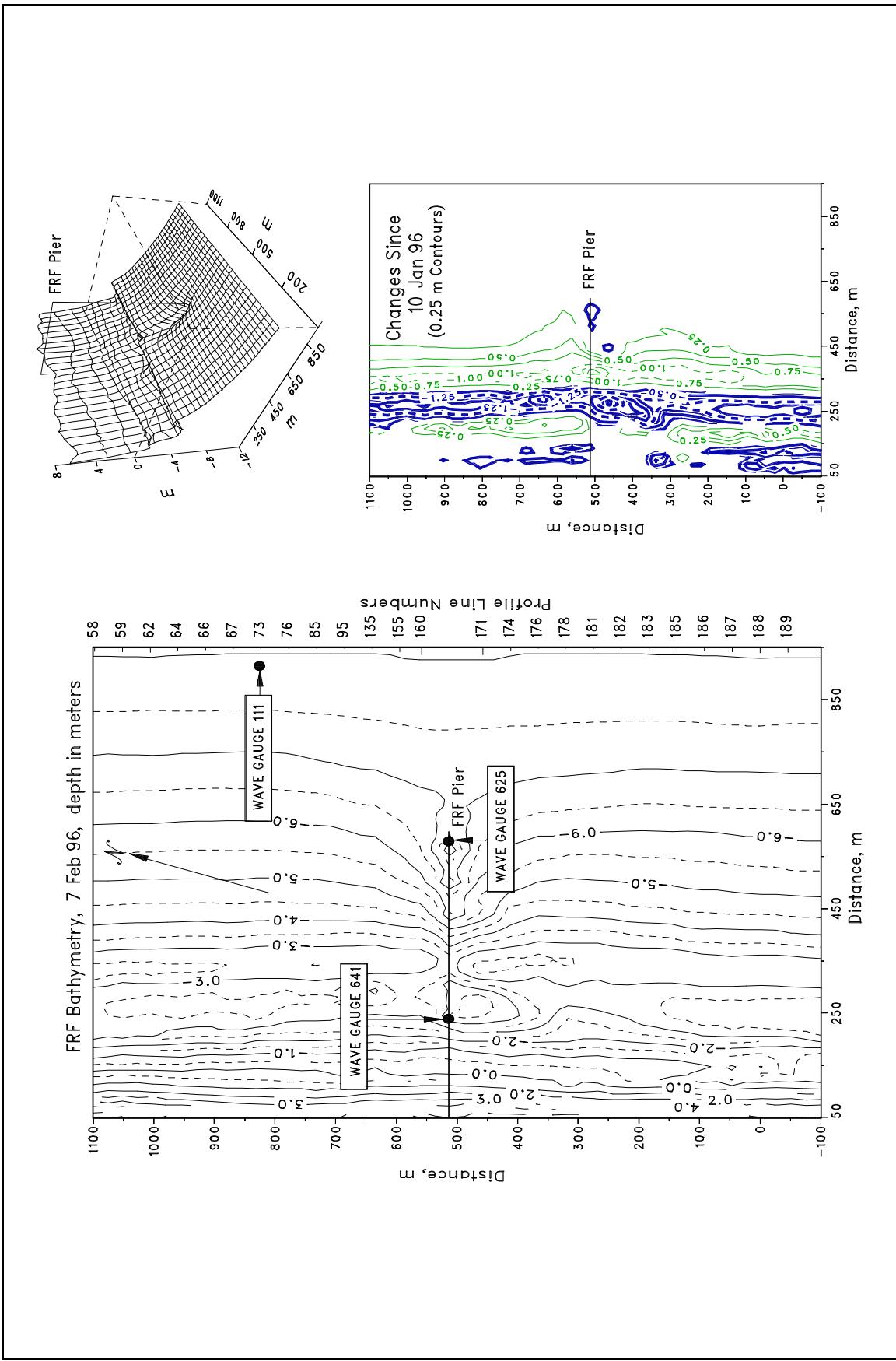


Figure 8. Profile Envelope - Profile Line 188.

B. Bathymetry. Figure 9 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 7 February. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.



Special Events

8

A. Storm Data Collection. The following list identifies times when the wave height H_{mo} at the seaward end of the pier exceeded 2 m.

<u>Start</u>	<u>End</u>
02 Feb (2116)	05 Feb (1000)
16 Feb (1142)	17 Feb (0808)

B. Storm Synopsis.

02-05 Feb A "Nor'easter" (low pressure system) moved along the coast, remaining offshore. Maximum onshore winds (NE) reached 16 m/s at 2200 EST on 2 February. The minimum atmospheric pressure was 1008 mb. The maximum H_{mo} , at gauge 630, reached 3.2 m ($T_p=9.1$ s) at 0842 EST on 3 February. There was 38 mm of precipitation.

16-17 Feb A low pressure system that formed over Cape Hatteras produced maximum onshore winds (NE) reached 18.5 m/s at 1816 EST on 16 February. The minimum atmospheric pressure was 996 mb. The maximum H_{mo} , at gauge 630, reached 3.2 m ($T_p=9.1$ s) at 1934 EST on 16 February. There was 8 mm of precipitation.